upper extremity. In the two cases reported in 1890, no operation would be allowed. In the cases reported to-day, it is probable that an operation will be permitted.

From the analogy of congenital dislocations of the hip-joint, it would seem that this shoulder deformity is probably due to a lack of development of the glenoid cavity and the head of the humerus; these x-ray plates support this view, that in the normal position for the glenoid cavity there is a rudimentary glenoid, and that the glenoid cavity occupied by the rudimentary head of the humerus is developed in an abnormal position, so that, as was suggested in the report of the original two cases, the term "congenital misplacement" of the shoulder-joint would be a better term than congenital dislocation.

The operative treatment of true congenital misplacement of the shoulder-joint cannot be formulated until the conditions existing are seen and handled in any particular case.

189 BEACON ST., BOSTON, MASS.

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# THE DANGERS OF TUBERCULAR INFECTION AND THEIR PARTIAL ARREST BY CLIMATIC INFLUENCES.[1]

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IN reviewing the evidence of partial arrest of tubercular infection by climatic influence, all data of a general character have to be taken with great caution. The impression that in the arid or elevated regions of the world, consumption from being so rarely seen is not communicated from the sick to the well, is not at all proved from such imperfect and unreliable statistics as have generally been brought forward. The immunizing power apparently possessed by a climate may be really due to manner of life, such as isolation; and a life, day and night, in the open air; or selected lives, such as the early settlers of any country live, who, to cope with its hardships, have of necessity to be the strongest.

It is, therefore, only after a country has been settled some little time that indoor industries, over-crowding, and the general unsanitary environment of civilization exert their full action, that any reliable data concerning climatic arrest of infection can with real accuracy be computed, since no experiment is accurate unless conditions are equal or nearly so. Conditions are now, however, favorable for comparison, as the dry and elevated regions of almost the entire world have populous cities, whose inhabitants lead indoor lives, and whose environment closely approaches that of the dwellers in the dense civilized centres from which our statistics have for years back been taken; so that at the present day, comparative statistics of tuberculosis, collected with care, show the relation between a seaboard town and one at an elevation of six thousand feet, with a degree of accuracy and truth that leaves very little to be desired in a collection of scientific data.

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[1] Read at Congress of American Physicians and Surgeons, Washington, D. C., May, 1897.

I shall not burden you with a long list of dry details regarding the immunity conferred by different climates in cases of pulmonary tuberculosis. It has been found, as you no doubt are aware, that in certain elevations above the sea consumption has occurred very infrequently. On the high table-lands of India,[1] of Africa,[2] of the valleys of the Andes,[3] in some parts of Switzerland,[4] etc., consumption seems to be a rare disease, even when the population at this elevation (from three thousand feet upward) is an industrial one; and, when, as in South America and other places,[5] the natives are crowded together, favoring contagion, and have food not adapted to proper nutrition; still the rate from tuberculosis is very small as compared to the rate of deaths from this disease among the same people living at a lower altitude, although other conditions except the factor of elevation are the same. It is a law well established that consumption among all races and in all climates diminishes in a progressive ratio as we ascend from the sea-level. There are, however, exceptions to this law, but they are more apparent than real. As, for instance, in Iceland consumption is a very rare disease, as in the Hebrides and Faroe Islands,[6] also among the inhabitants of the Russian Steppes.[7] Parts of Algeria also have a singular immunity; but it is well to remark that, to a great degree, the immunity ceases to be observed when the inhabitants of the countries are brought into contact with consumption, as in the Sandwich Islands, where it was not known until the advent of the white man;[8] or when these natives change their mode of life, as to industrial indoor occupations from agricultural outdoor ones. These factors act quite as readily in trading stations in North Greenland as on the borders of the Soudan.

Elevation is the only climatic environment which seems to confer any marked immunity, as I shall show from the history of cities situated much as those in Colorado, where, notwithstanding overcrowding, indoor occupation, contact with tuberculosis in every form, the increase of the death-rate from non-imported consumption remains insignificant. Undoubtedly this is the effect of the high altitude.

There is, however, no absolute safety, no non-phthisical line to be drawn at a certain elevation. A few cases do occur at any elevation.

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[1] Evans: Phthisiology, p. 55.

[2] Ibid., pp. 58 and 60.

[3] Ibid., pp. 63-232.

[4] Ibid., quoting Müller's report, pp. 15-237.

[5] Ibid., quoting Gross, p. 233.

[6] Ibid., quoting Schleisner, p. 46.

[7] Ibid., p. 47.

[8] Evans, p. 57.

I, myself, have seen three deaths from acute tuberculosis in renegade Ute Indians, who had never been out of Colorado or Utah, or been lower than six thousand feet; who had never lived in a house, and who did not use beef or milk for food; who assured me that they had never seen or been near a white man or Indian with a cough. I also saw, some months ago, a white man, an American silver miner, who had lived in the hills of Colorado for twelve years, at an altitude of never less than eight thousand feet, far from any town or any one ill in any way, and whose food, air, exercise, family history, etc., were ideally perfect from a health stand-point; yet this man had lost some forty pounds in weight in four months and presented a typical case of phthisis in the second stage, with bacilli in sputa. So that no absolute immunity does exist from consumption in mankind due to altitude and its effects. Cases do occur, as I have shown, even under the best conditions and at a very high altitude.

The fact, however, that its occurrence is so infrequent and that as we ascend higher and higher from the sea-level the cases are more infrequent, when other conditions remain the same, points to some definite climatic power at work which renders mankind less susceptidle to invasion of tuberculosis at certain elevations.

It has been to determine, if possible, what this protective influence is that I have been for the last few years engaged in investigation. I live in a city well adapted climatically to the purpose. Colorado Springs is at an altitude of six thousand feet. It has fourteen inches of annual rainfall, and, as you know, lies in our great so-called "dry plateau," the peculiar advantage being that it is well within the limited non-phthisical belt and has a population which has been engaged in indoor occupation for years, as in any Eastern city, besides having a large percentage of people infected with tuberculosis scattered among those who are well. For some twenty years consumptives have been coming to Colorado Springs, and the permanent population has been brought into close contact with them; so that, theoretically considered and from the stand-point of contagion, the population of Colorado Springs has been more exposed to the danger of infection from tubercular dust than the average city, and therefore should show at least a very large percentage of non-imported cases of consumption every year, or the climatic influence must arrest contagion, if other things are equal.

To determine the climatic effect, if any, upon germ life, I first considered the air, or, rather, the dust contained in the air and the germ life carried by this dust. The non-pathogenic micro-organisms were first taken up. The first experiment was to expose a Petri dish averaging about three square inches in area, the bottom covered with a thin layer of nutrient gelatin. After having been properly sterilized, these dishes or plates and gelatin are placed for a definite time in a certain place, and the germs and spores of moulds gradually settle upon the surface of the gelatin. This gelatin, covered and put away, develops a colony where each germ has fallen; and by counting the colonies one can tell how many germs or moulds have fallen during the time of exposure. These exposures were made for two years during every month of the year, and every hour during the twenty-four, both indoors and out. The comparative number of germs can best be shown by comparative tables. The germs I now speak of are not, be it understood, the germs of disease, but the comparatively harmless ones common to all large cities and countries. At the same time their number in a given space of air is a standard of its purity; and, to a certain degree, the number of harmless germs is more or less of an indication of the number of harmful ones, such as consumptive germs, scattered among them.

I find that from one part of Colorado Springs, compared with a like place in New York City, as nearly as any comparison could be made, the following (taking as a standard of comparison the analysis of Dr. T. M. Prudden, of the College of Physicians and Surgeons,[1] New York City):

| New York. | Colorado Springs. |
|---|---|
| Central Park, 499. | Pike's Peak Ave. (near Tejon), 89. |
| Union Square, 214. | Alamo Square, 23. |
| Private houses, 34. | Private houses, 39. |
| Dry-goods store, 199. | Dry-goods store, 99. |
| Street being cleaned, 5810. | Tejon and Huerfano Streets (a strong wind blowing, and dust), 753. |

We see, therefore, from this that, although our air is not at all free from dust and germs, it still has only a moderate number, and these only in city limits.

As the plate method, however, is subject to error, I supplemented it by Miquel's method, which is to draw a given quantity of air through a tube filled with granulated sugar or sand of a certain sized grain. This sugar or sand acts as a filter, and when the air is drawn through it by an air-pump, all germs contained in the air are entangled in the sugar. This sugar is then dissolved in gelatin and the gelatin is put away. By counting the number of colonies developed in the gelatin, we know how many germs were in the air drawn through the sugar in the tube. I found by this more elaborate method practically the same result that I had obtained by the plate analysis. I made, in all, several hundred experiments. A careful record was kept of all meteorological conditions, such as temperature, wind, sunshine, character of ground, height from ground, visible dust present in the air, etc. It was found that, as is usual in all cities of all climates, the germs increased in a regular ratio as the dense centre of population was reached and more dust was raised in the air by traffic. The actual tables would be too lengthy for this paper, but the main fact was established that the air of the prairies was absolutely germless. I applied the most crucial tests to determine this point, taking as much as ten metres of air at one test; and extending my observations from twenty miles out on the prairies up into the foot-hills at least to an altitude of ten thousand feet, deep down in some of the cañons, in dense timber, and again on exposed rocky ridges. The result was always the same, provided I had used the utmost care against accidental contamination. The air of the prairies and mountains I found absolutely sterile and germless; when, however, I approached any ranch with buildings, or came near barns, houses, etc., as on the outskirts of towns, I invariably found more or less germ life.

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[1] Dust and its Dangers, p. 26.

The comparative tables are as follows:

Dr. Prudden, New York, average of germs in lecture-room in 10 litres of air:[1]
Bacteria, 11; moulds, 14.

Colorado Springs Opera House (just after performance):
Bacteria, 15; moulds, 10.

Dr. Connelly, in Dundee (Scotland) Hospital, in 10 litres of air:[2]
Bacteria, 10 to 20.

Dr. Tucker, Boston, in hospital, in 10 litres of air:[3]
Bacteria, 20; moulds, 12.

Dr. Prudden, in New York, in various hospitals, in 10 litres of air:
Bacteria, 127; omulds, 25.

Colorado Springs, in various sanitariums and hospitals, in 10 litres of air: an average of about 25 to 50 bacteria and 11 moulds. In private houses, an average of 12 bacteria and 4 moulds.

Dr. Frankland, in open space in London, found in 10 litres of air, 35 bacteria; on roof of South Kensington Museum, 279 fell on one square foot in one minute; in Hyde Park, 24 bacteria in 10 litres of air.

From the above comparison it can be seen that in the dry elevated climate of Colorado Springs the ordinary number of non-pathogenic micro-organisms are present indoors or on the streets of the city. The dryness of the air probably assists their distribution by means of dust more effectually than in a more humid climate, but the general result is the same. The only point, therefore, bearing on the practical distribution of germ life ascertained by my experiments was the unusual and absolutely sterile condition of all the air not in the immediate vicinity of human habitations. This is a most important fact. Miquel has however, found the same absence of all germ life in Europe at an elevation of from two thousand to four thousand metres above the sea-level, while in the Rue de Rivoli, Paris, he found fifty-five thousand bacteria in ten cubic metres.

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[1] Ibid., p. 34.

[2] Ibid., p. 33.

[3] Ibid., p. 31.

I conclude, therefore, that there is very little proof that the actual number or kind of micro-organisms found in the air of a city at six thousand feet altitude has any relation to the non-development of tuberculosis; as, although the air generally is absolutely pure in our arid regions in the United States above four to six thousand feet, it is also a fact that in cities or towns at this elevation the air carries in its dust the ordinary number of bacteria and moulds that are found in cities or towns of the same population at a lower altitude, as at the sea-level.

These experiments on ordinary bacteria in the atmosphere in Colorado Springs and near by were extended so as to include a study of the separate bacteria present. Cultures were made on potatoes, agar, and other media, and the life-history of several micro-organisms not recognized from any description obtainable was made.

The result seemed to show that the climatic influence upon the development of non-pathogenic bacteria on ordinary nutrient media was negative; that dust taken from the atmosphere, out of doors or in, carried with it the usual number of ordinary bacteria and moulds that are found under similar conditions at lower altitude, combined with greater humidity; while the air obtained at a distance from buildings or roads was absolutely sterile.

The next point taken up was the effect of sunlight, combined with a minimum humidity, upon the vitality of tubercular bacilli in sputa.

It seemed reasonable to suppose that sputum, although it would become dry more rapidly in a dry air, and so prove a source of danger with less delay than under more humid conditions of the atmosphere, might also more rapidly lose its virulence exposed to a climate where the hours of sunshine are considerably in excess of those of most climates, and the diathermance of the air, or its thinness, contributing to the power of the sun's rays, acts as a germicide.

First having established the fact that fresh tubercular sputa injected into rabbits (either into the vein of the ear or the lower abdomen) produced a general tuberculosis within twenty or thirty days, quite as has been found under all climatic conditions, I selected the sputum which I had found contained tubercular bacilli, and from a patient, if possible, whose sputum had proved to be virulent at some previous time. This sputum was exposed to the direct rays of the sun for varying periods, and at different situations, with a background of sand, stone, or wood. After the exposure to the sun the sputum was rubbed up with sterilized water and inoculated into the thigh of a guinea-pig.

The animal was killed in from thirty to forty days after the time of inoculation. Some thirteen guinea-pigs were inoculated with 0.3 c.c. of sputa and water. The sputum was exposed to direct sunlight for from one hour and three-quarters to twelve hours. It was found that it took more time to dry the sputa in any quantity than was anticipated, and that, even when dried, the mass was so firm that the current of air from a blow-pipe failed to detach even minute quantities; so that, without in some way grinding up the sputa, when dried, as is done by wheels or soles of shoes, it really could not be said to be dangerous and capable of infection. The result, however, seemed to show that sputum so dried in the sun at six thousand feet altitude was quite as capable of giving local or general tuberculosis as elsewhere,[1] at least, taken as I took it, from a mass of at least two drachms, and not distributed in dust as it is inhaled. The tables show clearly the details and technique of my work, but show nothing more significant than I have stated regarding the effect of sunlight upon tubercular sputa.

The infectiousness of dust, such as exists in rooms occupied by tubercular patients, was now investigated. In each case at least a quarter to half a square yard of dust was taken by means of cotton swabs from backs of pictures and dark corners, and was suspended in sterile water; it was then inoculated into the thigh of a guinea-pig, 2 c.c. being used at each injection. As the largest hotel in Colorado Springs is more or less filled with invalids suffering from consumption, and as tourists and others in good health also frequently pass some time there in rooms that have been occupied, it was deemed of importance to determine, if possible, the infectiousness of dust from its rooms and halls. Eight guinea-pigs, therefore, were inoculated with dust taken from the walls of the hotel and walls of rooms occupied for several years. Of these eight guinea-pigs none developed any tubercular lesion, local or general. Two pigs died, respectively, on the ninth and tenth day after inoculation, and might have developed tuberculosis; but, as all their organs and glands were perfectly healthy, and showed no evidence after careful search for tuberculosis, it is doubtful.

These guinea-pigs were freshly imported from Ohio, and were inoculated within seven days of arrival in Colorado, allowing no time for them to become acclimated; and in this sense they represented travellers or tourists and not natives, whose immunity might possibly be due to prolonged residence at an altitude. The animals were kept in separate cages in a room twelve feet by six, where only a limited amount of sunshine ever penetrated, and the air space was also insufficient to make the experiment as severe as possible. In fact, my loss from this cause was a serious drawback to my work, and the pigs lost on the average one-half ounce in weight in forty days. The animals were killed after the thirty-seventh day, this being the time deemed sufficient for infection, as it had been found that animals inoculated with dried tubercular sputa and dust showed clear evidence of general tuberculosis, as a rule, earlier than reports from experiments of like nature at a lower altitude indicated.

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[1] Delepine and Ransome: Report on the Disinfection of Tubercular Infected Houses. British Medical Journal, February 10, 1895.

The non-infection of the dust was, no doubt, partially due to the general cleanliness observed, as after a room is vacated it is most carefully cleansed, fumigated, carpets taken up, etc. At the same time, the personal habits of the occupant suffering from pulmonary tuberculosis, in regard to his disposal of sputa expectorated, was in no way controlled, and was often, doubtless, careless in the extreme; and under the conditions present (judging from similar experiments made at lower altitudes) some of the guinea-pigs should have developed tuberculosis. Hance, to be sure, only lost five guinea-pigs out of eighty-one inoculated from dust taken from buildings of the Adirondack Cottage Sanitarium.[1] But in these buildings efforts are directed with great care toward a prompt disinfection of all sputa, a condition unknown in the occupied rooms examined by me, whose occupants were under no restrictions as to the care of the expectorated matter, ventilation, etc.

I also obtained dust from walls of rooms in a sanitarium filled with consumptive patients. Three of the rooms were occupied at the time by patients in the third stage of phthisis, who had to use cloths to receive their sputa. Dust was also taken from the general sitting-room, occupied by several patients all day. Four guinea-pigs were inoculated. One died on the twentieth day; no evidence of tuberculosis was found. The others were killed on the thirty-seventh day, and were free from disease. This result was only to be expected, as the very greatest care is exercised in this institution to insure a safe disposal of all tubercular sputa. Sanitary cuspidors are used and burned, and strict rules against expectorating anywhere else are rigorously enforced, except in the case of those bedridden, who use cheese-cloth, as mentioned.

The next experiment was to determine, if possible, how readily a guinea-pig could be infected through the air alone by dried sputa. Four guinea-pigs were confined in a cage, the sunlight, air-space, and ventilation of which resembled, in proportion to the weight, as nearly as possible, a room or rooms occupied by a consumptive patient in the city. Cheese-cloth rags were then washed in tubercular sputa of a known virulence and hung about, so as to infect the air when dried, although not to come actually in contact with the animals. Unfortunately, these guinea-pigs all died, from some unknown cause, too soon to make this test of value, and I shall repeat it.

In these experiments I have, it is true, been obliged to confine myself to so few animals as to preclude the possibility of any percentages being made, but it is only fair to state that the technique was conducted with great care, and in the case of dust taken from the hotel and sanitarium twelve guinea-pigs inoculated showed no trace of tubercular or septic infection. The control animals inoculated with sputa or with sputa and dust, with hardly an exception, developed local or general tuberculosis. I did not reinoculate any nutrient media to determine whether the lesions were produced by dead tubercular bacilli, but all nodules were examined microscopically, and the evidence of actual tuberculosis was most convincing.

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[1] A Study of the Infectiousness of the Dust in the Adirondack Cottage Sanitarium. Medical Record, 1896.

This opinion is not entirely based upon the report given. Some two years ago I inoculated in all fifty-eight rabbits with dust from twelve private houses, three hotels, two hospitals, and some public buildings, using as control experiments pure culture mixed with dust. I was so unfortunate as to lose practically the result of this work, as the brass tags on the rabbits were all changed by my assistant; also some rabbits were eaten by dogs, and some escaped. But enough data of a general character were obtained to prove at least the rarity of tubercular infection from any dust collected in houses, hospitals, etc., in Colorado Springs; also the infrequency of acute septic infection after inoculating with such dust—a fact I had seen strikingly illustrated in a surgical practice of some five years, in what was then the frontier of Colorado, far from any aseptic aids.

In taking dust from a general hospital in Colorado Springs, where there were many surgical cases in public wards, I did not lose 2 per cent. of my rabbits from septic infection. Cornot lost fifty-four guinea-pigs out of ninety-four by acute infection from dust from hospitals. Hance lost 55½ per cent. of them from acute infection after they were inoculated with dust from tubercular wards of a hospital in New York; and he points out the significant facts that mixed infection is so serious that a simple tuberculosis can be changed to a mixed infection in an atmosphere laden with infective germs, and that out of 543 guinea-pigs inoculated with dust 316 guinea-pigs, or 58 per cent., died of some septic disease developed by germs contained in the dust. In my experiments, out of fifty-eight rabbits inoculated with dust from hospitals and like places where ill people were collected, I lost but two animals from acute septic infection. Rabbits are probably less likely to develop infection than guinea-pigs; but of twelve guinea-pigs inoculated with dust from hotels and sanitariums none died of septic infection.

The question was brought very forcibly to my mind, from the results of my work in this direction, as to whether we do not owe much of the improvement in tubercular cases in Colorado to the absence of the septic germs in the atmosphere, indoor as well as out, quite apart from any climatic effect upon the tubercular germ pure and simple. This, of course, could only be determined absolutely by a much more extended series of experiments than I have taken. The important point, after all, and the most practical one, is how dangerous is it to live in Colorado Springs among consumptives? Are there any data to show the actual presence of cases that date their tubercular invasion to, in some way, contracting the disease by living in proximity to consumptives, as most well people do in Colorado Springs? In 1892 I published in The American Journal of the Medical Sciences all cases of non-imported consumption that I could find. At that time I personally interviewed every physician in Colorado Springs, and wrote to many who had lived there, besides obtaining testimony from each and every one I could in regard to the origin of consumption in the city. After two years I found and published a list, with their histories, of ten cases that had occurred in Colorado Springs during fifteen years.

Since that time, or from 1892 to April of this year, I have been collecting statistics. A circular letter was sent to every reputable physician practising in Colorado Springs, asking for a list of his cases of non-imported phthisis, seen or heard of, during his practice, and the number of years he has practised in the city. The number of years' practice represented was one hundred and forty-four and a half. Twenty cases were reported, including the ten reported by me in 1892. At any average city at the sea-level the rate of three deaths per thousand is acknowledged to be the average. At the same ratio, a city like Colorado Springs would have had in twenty years, with its constantly increasing population, from one thousand up to twenty thousand, a total rate of six hundred and thirty deaths, while it had in twenty years ten deaths (as not all the cases reported died). In 1896[1] but one case was reported to the city physician. The average town at a lower altitude, with twenty thousand inhabitants, would show sixty deaths from tuberculosis, presumably contracted there in one year.

The objection that in Colorado Springs statistics, based on a constantly changing population, are inaccurate, does not hold. Colorado Springs, unlike most health resorts, has a permanent population. People who live there make the place their home, winter and summer, and have done so for years; many of them are engaged in indoor occupations and business life generally, quite as in any city, the proportion of tubercular to non-tubercular inhabitants being one invalid to every six people. Many of the inhabitants are predisposed to contagion by family history, having come to Colorado on account of consumption in some member of their family. The tubercular and non-tubercular mingle together in a most promiscuous manner; yet, in spite of these conditions, which have gone or for years, the actual rate of death from non-imported tuberculosis is so far below the rate in any average city in the United States as to make Colorado Springs, as a matter of fact, probably the least dangerous place to live in, judged from the non-imported tubercular death-rate, about which we have any information.

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[1] Colorado Springs Health Department, Dr. B. H. Grover, Health Officer, 1895-96.

Of the cases of non-imported consumption that did occur in Colorado Springs, one only could be traced clearly to infection. In this case, a robust man in the prime of life, who had lived in Colorado for eighteen years, occupied a tent with a man ill of consumption. This patient expectorated very frequently on the dusty floor of the tent, and the result was a very clear case of infection, as his companion, inside of four months, developed a cough and pulmonary hemorrhages, with bacilli in sputa, although an unusually strong and athletic man. His subsequent history was a decided improvement in El Paso, Texas, to which place I ordered him. There was a gain of forty-two pounds in weight, but then he began to lose weight, much as he did in Colorado; and on his return to Colorardo he died of tubercular laryngitis.

In all other cases there was no direct evidence of infection, but, on the contrary, those developing consumption, as far as could be observed, were far less exposed to infection than even the average inhabitant of Colorado Springs; and some of the cases lived far from any consumption or possible source of contagion, as on isolated ranches. Family history and childbirth were far more frequently the apparent predisposing cause; occupation was quite a negative factor. All were under the best conditions as regards nutriment, and no syphilis or exposure to weather could be traced. In two cases over-exertion seemed to play an important part in inducing hemorrhages; and in one case a fall from a horse had a like effect. The general result was fatal. The disease ran a more rapid course than the average case of consumption; some 80 per cent. died at the end of the second year from the time the first symptom of the disease was observed. Pulmonary hemorrhage was no more frequent in these cases than in cases contracting the disease elsewhere. The sputa showed very much the same characteristics as observed in cases that were imported; tubercular bacilli averaged in number and shape the same; there was no more and no less elastic tissue, and streptococci, with ordinary micro-organisms, showed nothing unusual due to climatic influences.

In regard, therefore, to infection, the fact that so many consumptives are brought into such close contact with well people in Colorado Springs seems, no doubt, a clear evidence that a risk in proportion to the exposure must logically result. Theoretically considered, such an opinion, based on well-known laws and statistics of other cities, would be safe to follow, other things being equal; but other things are not equal. A factor of six thousand feet altitude comes in, and, as I shall show, not theoretically but practically from statistics, this six thousand feet exerts a very strong and important action in limiting the extension of tuberculosis in Colorado Springs. This is also not an isolated instance;

Colorado Springs is not alone in having such a low record. The low mortality from non-imported consumption contracted in Colorado Springs has its counterpart in other cities in this elevated dry belt. Even Denver, a city of 150,000 inhabitants, with tall buildings shutting out the sunlight, industrial occupations which are so conductive to tubercular increase, and, in addition, a large proportion of consumptive invalids scattered among its other inhabitants, had, as shown by the reports, only sixty-four deaths from non-imported consumption (less than half of a death to the thousand) in 1896.[1] The average city would show four hundred and fifty deaths per year to 150,000 inhabitants, without the climatic factor possessed by Denver. I sent out in April fifty circular letters to doctors in Utah, Arizona, Wyoming, New Mexico, and Colorado, asking the number of cases seen or heard of by them, and the number of years each had practised in his present locality. In this way I took in fairly well the dry belt, some of which was at one thousand feet altitude only. The result from answers received was two hundred and three years' observation in practice and one hundred and thirty cases of non-imported phthisis reported—fully 80 per cent. of which were either from Salt Lake City, in native Mexicans in New Mexico, or in an altitude below three thousand feet. This compares well with results observed in other parts of the world. Hirsch, in quoting Corbal, states that in the Grand Duchy of Baden phthisis increases in a regular ratio to the increase of population, due to overcrowding, but probably more especially to indoor occupations taking the place of outdoor or agricultural ones. It was also found that phthisis diminished in a regular ratio as the altitude increased, so that my results show merely what had been observed before, with the exception that a town being filled with phthisical invalids did not seem to affect the result in the slightest degree. So far as I could judge, the factors of bad nutrition, overcrowding, indoor occupations, and low altitude contributed the main factors toward the phthisical increase in a climate the effects of which are to confer an immunity from tubercular infection as a rule.

The point of interest now comes up as to what factor in a dry elevated climate confers, to such a great degree, immunity from tubercular infection. As has been shown, in very many respects the sanitary environment of people in such cities as Colorado Springs and Denver closely resembles that of the inhabitants of any average city in the United States. A constant population has lived for years, occupied in indoor occupations—a population much more exposed to contagion from dried sputa in the atmosphere than any average city, as the tubercular invalids are so markedly in excess—and then many are predisposed by family history to the disease, so that if other things were equal it would be only logical to infer that a very large death-rate from non-imported consumption should occur. The reason that it is not so and that the death-rate is so low compared to other cities must be some climatic influence. This climatic influence, that also favors recovery from consumption, is, no doubt, composed of many factors. Very briefly, they can be stated as follows: The tubercular germ distributed as dust is much more likely to lose its virulence, exposed in a climate where the sunshine is so constantly present and the air is so thin. The air-cells of the average lungs are more used, more brought into healthy action, at an altitude of six thousand feet. The increase, as told by the spirometer and by chest measurements, is very marked in new-comers to the dry elevated climate; and it follows that organs so exercised, both by increased ventilation and by increased blood supply, do not so readily become a suitable medium for the growth of tubercular bacilli.

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[1] Denver Bureau of Health, W. P. Munn, Health Commissioner. Report for 1895-96.

### EXPERIMENTS TO DETERMINE THE EFFECT OF SUNLIGHT UPON TUBERCULAR SPUTUM.

Animals used, guinea-pigs. Seat of inoculation, left thigh.

| Number of animals inoculated with exposed sputum. | Length of exposure. | Number inoculated with non-exposed sputum. | Of which died within 20 days with | | Of which died or were killed after 30 days, having | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Local tuberculosis. | Other diseases. | General tuberculosis. | Glands generally and spleen affected. | Glands or abscess local. | Other diseases. |
| 1 | 1¾ hrs. | ... | ... | ... | 1 | | | |
| 4 | 2h. 5m. | ... | 2 | 1 | ... | 1 | | |
| 2 | 24 hrs. | ... | 2 | | | | | |
| ... | ... | 6 | 1 | 3 | 1 | ... | 1 | |

### EXPERIMENTS WITH DUST FROM HOTEL AND SANITARIUM.

| Animals inoculated with dust from | | | | No. died on 9th or 10th day. | No. died on 20th day. | No. died on 36th day. | No. killed between 36th and 40th day. | No. showing any tubercular affection. | No. died of other causes. | Number square yards dust used. |
|---|---|---|---|---|---|---|---|---|---|---|
| Halls of hotel. | Sleeping-rooms of hotel. | Sitting-rooms of sanitarium. | Sleeping-rooms of sanitarium. | | | | | | | |
| 5 | ... | ... | ... | ... | ... | ... | 5 | ... | ... | ½ s. yd. |
| ... | 3 | ... | ... | 2 | ... | ... | 1 | ... | 2 | ½ s. yd. |
| ... | ... | 1 | ... | ... | ... | 1 | ... | ... | 1 | 1 s. yd. |
| ... | ... | ... | 3 | ... | 1 | ... | 2 | ... | 1 | 1 s. yd. |

| Date. | Experiment number. | Quantity of sterile water used to dilute dust. | Quantity of solution inoculated. | Dust taken from sanitarium or hotel. | Occupancy of rooms by phthisical patients. | Number of bacilli found in sputum of occupant. | Stage of disease patient suffering with. | Sq. yards of dust used. | Number of days animals lived after inoculation. | Extent of tubercular affection. | Died of other diseases. | Number of days animals had lived in Colorado before inoculation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| March 4, 1897 | 1 | 2½ c.c. | 2 c.c. | Hotel. | Halls. | ...... | ...... | ½ sq. yd. | Killed 36 days. | Negative. | ...... | 7 days. |
| March 4, 1897 | 2 | 2½ c.c. | 2 c.c. | Hotel. | Halls. | ...... | ...... | ½ sq. yd. | Killed 37 days. | Negative. | ...... | 7 days. |
| March 4, 1897 | 3 | 2½ c.c. | 2 c.c. | Hotel. | Halls. | ...... | ...... | ½ sq. yd. | Killed 37 days. | Negative. | ...... | 7 days. |
| March 4, 1897 | 5 | 2½ c.c. | 2 c.c. | Hotel. | Halls. | ...... | ...... | ½ sq. yd. | Killed 38 days. | Negative | ...... | 7 days. |
| March 4, 1897 | 6 | 2½ c.c. | 2 c.c. | Hotel. | Halls. | ...... | ...... | ½ sq. yd. | Killed 40 days. | Negative. | ...... | 7 days. |
| March 4, 1897 | 7 | 2½ c.c. | 2 c.c. | Hotel room. | 4 months. | ...... | ...... | ½ sq. yd. | Died 9 days. | Negative. | Intestinal causes. | 7 days. |
| March 4, 1897 | 8 | 2½ c.c. | 2 c.c. | Hotel room. | 4 months. | ...... | ...... | ½ sq. yd. | Died 10 days. | Negative. | Intestinal causes. | 7 days. |
| March 4, 1897 | 48 | 2½ c.c. | 2 c.c. | Hotel room. | 4 months. | ...... | ...... | ½ sq. yd. | Killed 40 days. | Negative. | ...... | 7 days. |
| March 3, 1897 | 24 | 2 c.c. | 2 c.c. | Sanitarium. | Sitting-room | ...... | ...... | ½ sq. yd. | Died 36 days. | Negative. | Exposure. | 6 days. |
| March 3, 1897 | 25 | 2 c.c. | 2 c.c. | Sleeping-room, sanitarium. | 4 months. | 2 to 3 in field. | Third. | 1 sq. yd. | Killed 37 days. | Negative. | ...... | 6 days. |
| March 3, 1897 | 26 | 2 c.c. | 2 c.c. | 2 sleeping-rooms in sanitarium. | 4 months, 3 weeks. | 2 to 3 and 10 to 15 in field. | Second. | 1 sq. yd. | Died 20 days. | Negative. | Unknown | 6 days. |
| March 3, 1897 | 27 | 2 c.c. | 2 c.c. | Sleeping-room, sanitarium. | 6 months. | 1 or 2 to field. | Second. | ½ sq. yd. | Killed 40 days. | Negative. | ...... | 6 days. |

The blood itself is markedly changed at six thousand feet altitude.[1] It has been shown by Egger and Paul Bert in the Andes, Muntz, Vicault, Koeppe, and Woolif in Europe, that the blood in individuals living at six thousand feet and upward above the sea is increased in specific gravity, with, also, an increased number of red corpuscles and an increase of hæmoglobin, giving the blood greater power to absorb oxygen; and, with all this, also an increased muscular power of the heart, thus insuring to the blood in several ways an increased germicidal power, and, what is probably more important, a stimulation to tissue change—all of these conditions of the blood being antagonistic to tubercular infection.

The tonic effect of altitude and cold nights is, too, a stimulant of decided value to the nervous system, much as strychnine acts, by increasing the appetite, etc. There is also the dryness to be considered, the absence of moisture in the air itself being well known at any considerable altitude, the dryness of the soil probably being the more important of the two. Bowditch, Buchanan, Pepper, Trudeau,[2] Elliot—all have shown that the relation between damp soil and phthisis is a constant one; and, no doubt, some subtle influence exists by which our dry regions, such as Colorado, etc., with sandy and gravelly soil, exert an effect on the extension of tuberculosis.

Then, also, as it is now known that tubercular infection frequently arises from milk or the meat of tubercular cattle, that danger is now reduced to a minimum in Colorado and like climates. I will quote from an article of mine published elsewhere:[3] "These facts are not confined to mankind. A general immunity, from living in this country, is also found in domestic cattle. In dairy herds, where general environment, character of food, shelter, and all conditions bearing on general health are far more likely to be the same in any climate than those of man, we have the same result, viz., that consumption in the native cattle of Colorado is a most infrequent occurrence. Careful reports show that, all through a large part of the United States, cattle are sacrificed to this plague of tuberculosis or consumption, and the opinion is gaining ground that milk taken from cows so diseased and used for food is, in a large measure, responsible for many cases of consumption occurring in mankind. Reports show that some 25 to 50 per cent. of the cattle of humid and non-elevated States are tuberculous. The reports of the State Veterinary for Colorado show only 2 per cent. in our herds (when the tuberculin test has been made). I am assured that it is so rare a disease among Colorado cows that it is almost a curiosity; and when it does occur, it is usually either in animals that have had the worst of care as regards overcrowding or in imported animals; native cattle are nearly immune. The testimony from all over our high dry plateau, at from five to eight thousand feet altitude, is the same. So, if it is true that consumption is very often contracted by drinking milk from consumptive or tubercular cows, the fact of Colorado's cattle being so remarkably exempt from this disease only adds another factor to our safety. If only two cows to the hundred have consumption in Colorado and twenty-five to fifty to the hundred have consumption in the East and elsewhere, there is not much room for doubt as to the comparative danger from milk infection. In a drink of milk taken in any of our average cities below two thousand feet altitude we run about 30 per cent. more risk of taking consumption than we do from a glass of milk in Colorado."

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[1] Solly, Therapeutic Gazette, February, 1896, quotes Dr. Egger's paper read at Congress für Innere Medicin, 1893.

[2] Environment in its Relation to the Progress of Bacterial Invasion in Tuberculosis. American Journal of the Medical Sciences, July, 1887.

[3] Gardiner: Letter to the Sun, New York City, April, 1897.

An interesting question is, Will such an immunity as exists, for example, at Colorado Springs remain constant? I think that it will, for the following reasons: We know that, as regards indoor occupation, contact with tubercular invalids, and lack of sanitary precautions, the maximum danger has been about reached. For some years past all these factors have had full opportunity to exert their baneful influence, and the results show for 1896 no increase in non-imported consumption; and in the future, although it is true the city may become more crowded, this fact or danger will be clearly met and defeated by the sanitary precautions enforced, as a law passed in 1897 fines any one from one to five dollars for expectorating on the sidewalks; and the sanitary condition of the city will be constantly improved to such a degree that it is safe to predict that we can not only keep our present low percentage of infection from tuberculosis, but will even lower it in the future.

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# MULTIPLE SCLEROSIS IN CHILDHOOD,

## WITH A REPORT OF THREE CASES.

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The first case of disseminated sclerosis occurring in a child was published by Schuele in 1871. It is at the same time one of the three cases of the kind in which an autopsy confirmed the clinical diagnosis. Schuele's case was followed by the publication of a number of English observations (Dreschfeld, Pollard, Bristowe, etc.), and in 1879 by the report of two cases from Erb's clinic by Ten Cate Hoedemaker, who, in reviewing the cases previously recorded, only accepted Schuele's and